

December 9, 2019

**Ex Parte**

Marlene Dortch, Secretary  
Federal Communications Commission  
445 12th Street SW  
Washington, DC 20554

Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz*, GN Docket No. 17-183

Dear Ms. Dortch:

On December 5, 2019, representatives of Apple Inc., Broadcom Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, and Qualcomm Incorporated met with the Office of Engineering and Technology. A complete list of attendees in that meeting is attached.

We discussed the attached presentation which demonstrates that VLP devices do not pose a harmful interference risk, even in the extreme corner case described in the presentation. We emphasized that VLP devices are critical for enabling two important use cases:

1. Personal area network (“PAN”) applications, where devices will be exclusively battery powered and designed for either handheld use or to be worn on the user’s body. Examples of PAN devices would include smartphones, glasses, watches, and earphones.
2. Vehicular applications, where devices are designed to be installed in automobiles or other terrestrial vehicles. An in-dash display unit would be a typical example of a vehicular VLP device.

In both of these cases, the specific use case will also result in significant attenuation between the VLP device and FS receivers. In the case of PAN devices, body loss will further attenuate the already very low power emissions, providing additional protection to FS receivers.<sup>1</sup> In the case of vehicular devices, emissions will also be subject to vehicle penetration loss.

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<sup>1</sup> We noted that the Commission previously concluded that 3 dB of body loss was appropriate for devices operating in the 600 MHz band, making 4.5 dB an appropriate estimate for the 6 GHz band where a far higher frequency significantly amplifies the effects of body and other losses. *Amendment of Part 15 of the Commission’s Rules for Unlicensed Operations in the*

We also detailed the important role that transmit power control (“TPC”) will play in enabling VLP applications. VLP devices are expected to provide a very high throughput, low latency experience for digitally immersive video, similar to what Bluetooth provides for audio today. Transmit power control for VLP devices is expected to operate in a similar manner as Enhanced Power Control for existing Bluetooth devices. Beginning with Bluetooth version 3.0, Enhanced Power Control allows Bluetooth devices to operate with a 28 dB range, which maximizes battery life by lowering power to take advantage of changes in body loss.<sup>2</sup> Transmit power control will achieve the same objective for 6 GHz VLP devices. In the example we discussed, the link from the handset is expected to have only 4.5 dB in body loss, operate within one meter, and be capable of reducing its radiated power to 0 dBm (a 14 dB reduction) while still achieving throughput of approximately two gigabits per second. If the user placed the handset in their pocket or bag, TPC would increase power up to the necessary level in order to compensate for this additional path loss, but these higher losses will also reduce the energy emitted towards FS receivers. In both cases, a combination of TPC, body loss, and other losses will prevent harmful interference to FS receivers.<sup>3</sup> Notably, some classes of unlicensed devices are already required to implement a version of TPC in other bands under existing FCC rules.<sup>4</sup>

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*Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37*, Report and Order, 30 FCC Rcd. 9551, ¶ 125 (2015).

<sup>2</sup> See CSR, Enhanced Power Table Construction Application Note (2006), [http://netlab.cs.ucla.edu/wiki/files/Enhanced%20Power%20Table%20Construction%20\(bcore-an-054Pd\)%20.pdf](http://netlab.cs.ucla.edu/wiki/files/Enhanced%20Power%20Table%20Construction%20(bcore-an-054Pd)%20.pdf)

<sup>3</sup> See, e.g., ECC Report 288, 68 (2019), <https://www.ecodocdb.dk/document/8213> (explaining the operation of automatic transmit power control and concluding that “ATPC is beneficial to [Multi gigabit wireless systems] operation alone, and to [Multi gigabit wireless systems] and FS coexistence. It should be considered as one of the most effective dynamic methods for spectrum sharing.”)

<sup>4</sup> See 47 C.F.R. §§ 15.407(h), 15.709(e).

Ms. Marlene H. Dortch

Dec 9, 2019

Page 3 of 4

We also discussed the information enclosed describing the real-world duty cycles of 5 GHz devices, across a large-scale carrier-grade deployment. We noted that this reflects average data from a residential deployment. Other types of scenarios, such as enterprise deployments, may exhibit higher duty cycles. Nonetheless, this data is highly instructive. It shows that 90% of the 5 GHz radios in residential Wi-Fi access points use less than 1% of the available airtime during peak usage. Even at the 99<sup>th</sup> percentile, airtime consumption is only 7%. Because 6 GHz devices will be even more spectrally efficient than 5 GHz RLAN devices, 6 GHz RLAN duty cycles can be expected to be lower still.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul Margie".

Paul Margie

*Counsel to Apple Inc., Broadcom  
Inc., Cisco Systems, Inc., Facebook,  
Inc., and Google LLC*

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VLP

Coexistence

Analysis

# VLP Background

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Very-low-power (VLP) devices are a critical indoor/outdoor device class for enabling 5G speeds to mobile peripherals.

**Use cases:** Personal area network applications such as Immersive AR/VR; mobile peripherals; in-car connectivity.

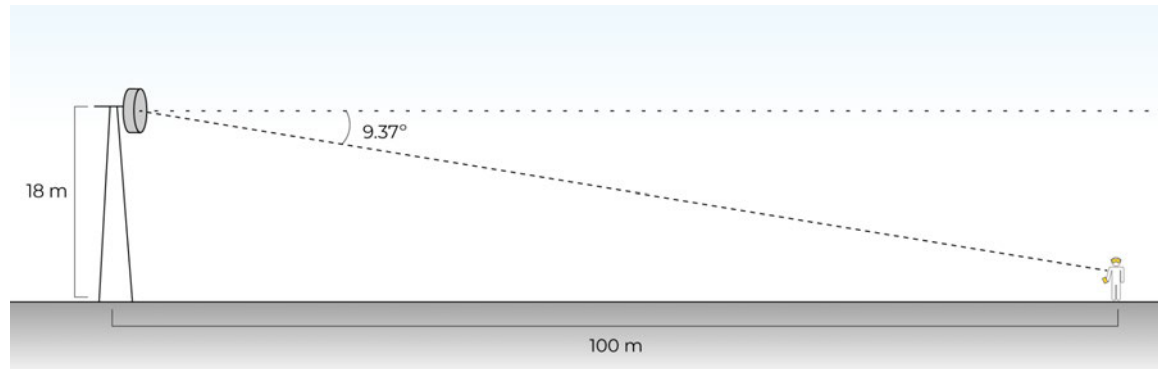
**Extremely low power levels:** No higher than 14 dBm EIRP (25 mW). These power levels are too low for use in Wi-Fi routers and other infrastructure.

**Short range:** Generally far less than three meters.

**Battery-powered:** VLP devices will transmit infrequently and at the lowest power possible.

**Antenna directivity:** Peak gain will never be realized from all antennas in the exact same direction.

# Analysis: Mobile Peripheral at Ground Level Near Very Low FS Receiver



Even in this highly unusual geometry, a VLP device will not cause harmful interference to an FS receiver.

- This analysis assumes a very low FS receiver height of 18 m and very short distance to the VLP device (100 m).
- In this geometry, very high off-axis rejection by FS receiver greatly dominates propagation loss (which is assumed to be free space).

*Additional assumptions: 6 ft FS antenna size; 30 MHz FS bw.*

<b>RLAN Bandwidth</b>	160 MHz
<b>Maximum RLAN EIRP</b>	14 dBm
<b>Body Loss / Transmit Power Control</b>	-18 dB
<b>Effective RLAN EIRP</b>	-4 dBm
<b>Feeder/System Loss</b>	-2 dB
<b>Polarization Mismatch</b>	-3 dB
<b>Antenna Mismatch</b>	-3 dB
<b>FS-RLAN Distance (horiz.)</b>	100 m
<b>FS Gain (@9.37 degrees)</b>	4.86 dB
<b>Prop. Loss (FSPL)</b>	88 dB
<b>TOTAL I/N</b>	<b>-8.2 dB</b>

# All VLP Devices Will Use TPC to Maximize Battery Life

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VLP devices will be designed to maintain very high-speed connections and optimize power consumption, with or without body loss.

When the device is held away from the body in the user's hand – a range of approximately 1 meter – devices will lower transmit power to conserve battery life while still maintaining the user experience.

In this example, a device will transmit at 0 dBm (14 dB lower than maximum EIRP) due to TPC (including 4.5 dB of body loss) while enabling applications at approximately 2 Gbps.





# Usage Patterns of VLP Devices Will Further Reduce the Risk of Harmful Interference

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VLP devices will fit into one of two categories:

1. Personal Area Network (“PAN”) devices
2. Vehicular devices

# PAN Operations Will Reduce FS Interference due to Body Loss and TPC

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PAN devices will be designed for battery-powered body-worn or handheld use.

These use cases ensure that the combination of body loss and TPC will prevent harmful interference.

This is in addition to other types of loss in common scenarios, such as BEL and vehicle penetration loss.

# VLP Devices Installed In Vehicles Will Be Even More Protective than PAN Applications

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Other VLP devices will be designed to be installed in vehicles.

These will include applications such as in-dash wireless connectivity.

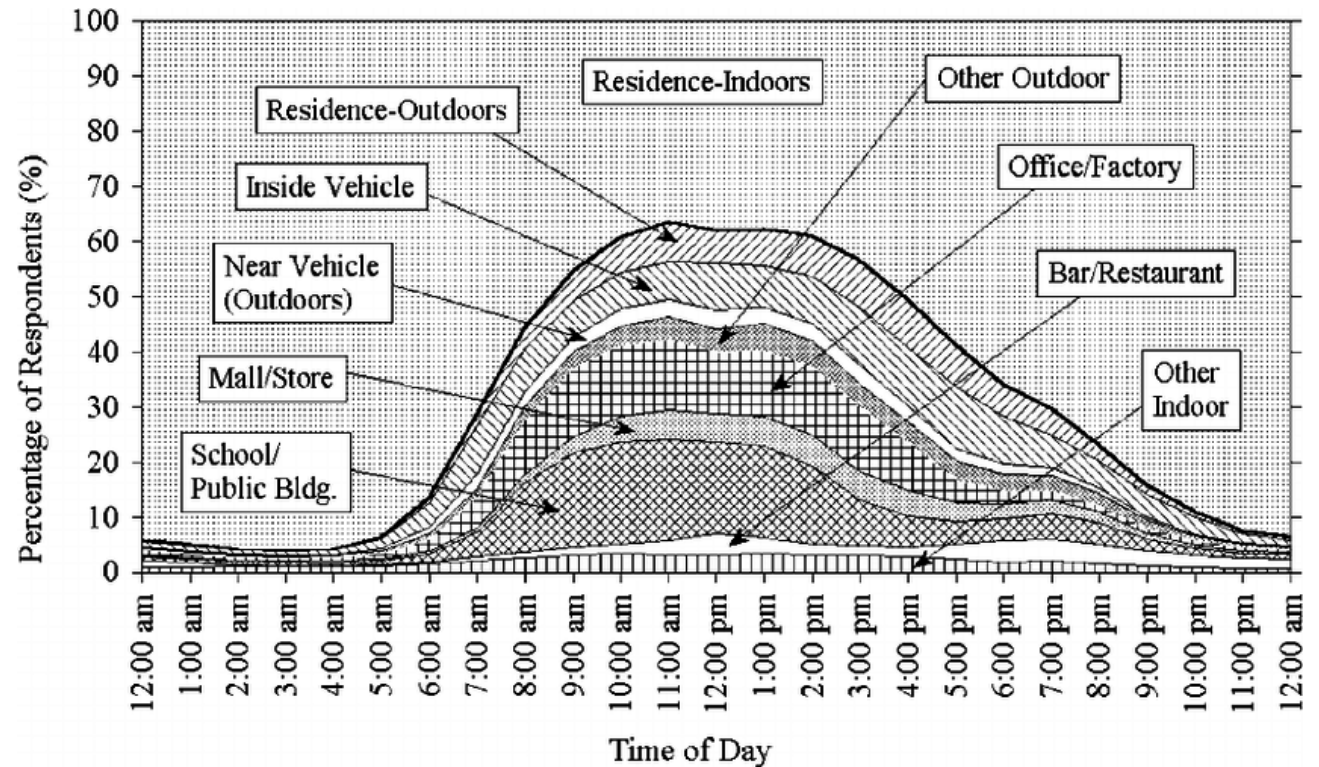
Because they will only be installed in vehicles, these devices will exhibit at least 10 dB of vehicle penetration loss, providing additional protection for FS receivers.

# FCC Analysis Should Assume VLP Operates Outdoors Less Than 10% of the Time

VLP devices will operate at very low duty cycles.

Moreover, VLP will be outside on average less than 10% of the time.

The periods of peak outdoor use occur when multipath fade is least.



N. E. Klepeis, et al., "The National Human Activity Pattern Survey (NHAPS)," Journal of Exposure Analysis and Environmental Epidemiology, vol. 11, no. 3, p. 231–252, May-June 2001.

# Duty Cycle Data

December 5, 2019

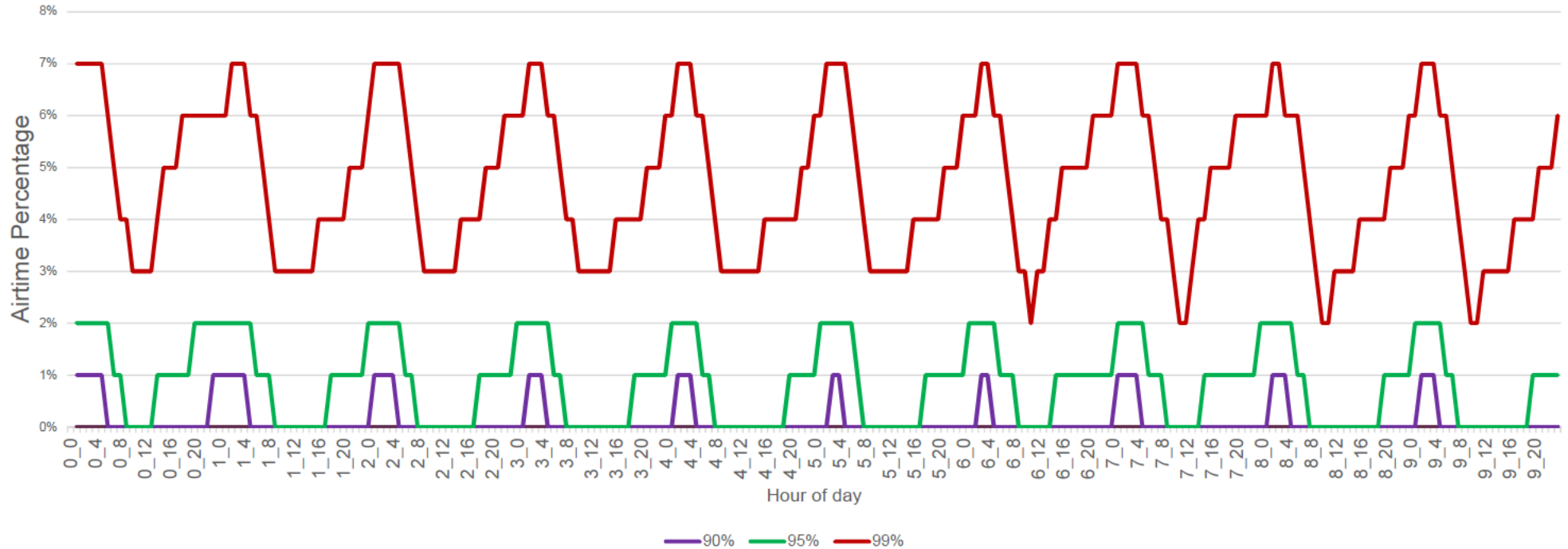
# Introduction

- The record demonstrates that the average duty cycle for a Wi-Fi device operating in the 6 GHz band will be extremely low → less than 0.5%. This is the case for a variety of reasons. For example:
  - Activity factors related to human behavior (e.g., one person may be streaming video while another is driving, sleeping, eating)
  - Not all internet activity has the same bandwidth requirements (e.g., downloading email ≠ streaming video ≠ browsing)
  - RLAN transmissions are bursty and intermittent, even for bandwidth intensive applications such as streaming video
  - 6 GHz RLANs are expected to be based on the most advanced technologies (e.g., Wi-Fi 6)
- To supplement the record, this presentation describes measurements over a ten-day period obtained by Broadcom from one of its customers
- The data is intended to be representative of consumer only, and does not reflect enterprise deployments, which can exhibit different and higher duty cycles, depending on a variety of factors.

# Methodology

- Duty cycle information obtained from ~500,000 unique residential access points for 10 days
- Measurements based on total airtime utilization per radio based on rolling counters that increment with microsecond granularity
- Measurements aggregated over 15-minute intervals, totaling over 450 million data points
- Data points are from various time zones located throughout the US and oriented to a single time zone (e.g., data points at 5PM ET, 4PM CT, 3PM MT, and 2 PM PT were applied at a single time zone)

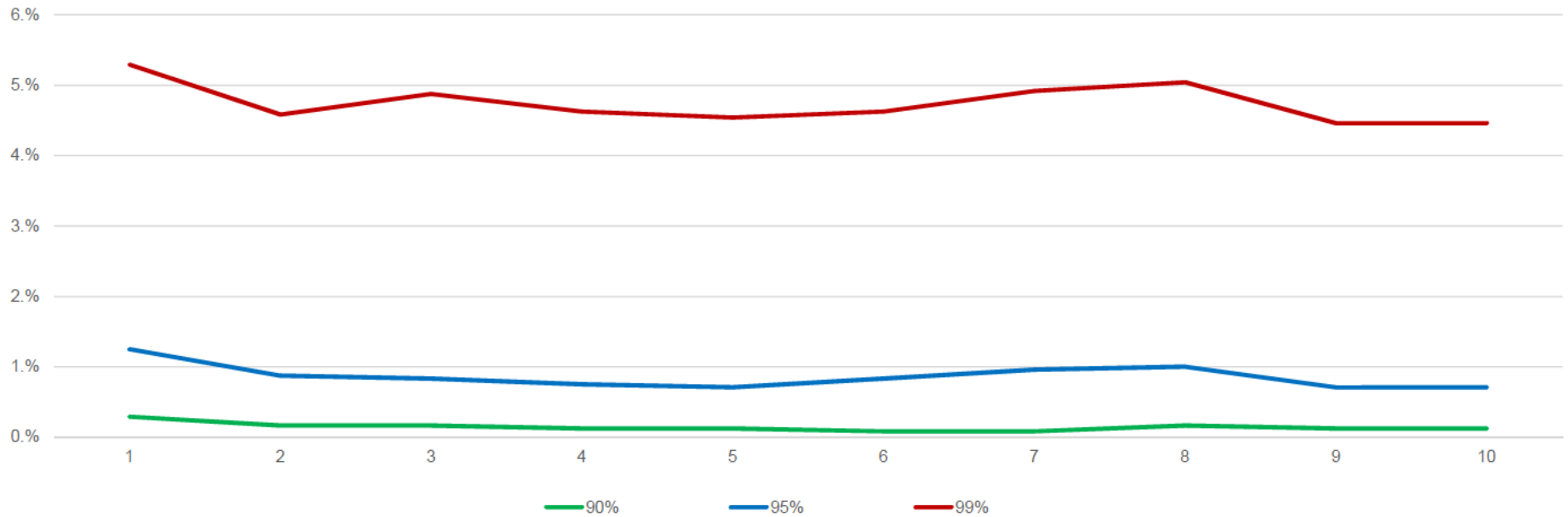
# 5 GHz Duty Cycle Over 10-Day Period



- 99% of the time less than 7% of airtime is being used even during peak usage
- 95% of the time less than 2% of airtime is being used even during peak usage
- 90% of the time less than 1% of the airtime is being used even during peak usage



## Airtime usage in 5 GHz continued: daily average



- Total airtime utilization averaged over entire 24-hour basis per day
  - 99% of time less than 5.5% of airtime is being used on daily avg.
  - 95% of time less than 1.25% of airtime is being used on daily avg.
  - 90% of time less than 0.25% of the airtime is being used on daily avg.

## Conclusion

- Real world residential Wi-Fi duty cycle data demonstrates that RLANs are quiet far more often than they are transmitting energy
- Multipath fading events and RLAN transmissions are not correlated
  - As we have indicated in our analysis on multipath fading, deep multipath fading is extremely rare (measured in seconds even during the worst month of the year)
  - The rarity of deep fade events and RLAN behavior mean that an FS link that is designed for 99.999% availability will to continue to operate at 99.999% availability with RLANs in the band

# Thank You

